



Montana Fish, Wildlife & Parks

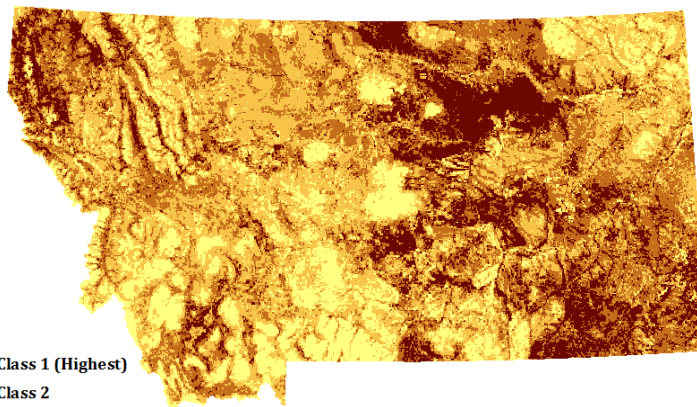
Crucial Areas Assessment



TERRESTRIAL CONSERVATION SPECIES

SUMMARY: This layer represents the cumulative expected occurrence of 85 of Montana's vertebrate species. Species inclusion was based on the State Species of Concern (SOC) list. The SOC list includes federally **listed Threatened or Endangered species**, those

species listed Species of Greatest Conservation Need as part of the Montana Comprehensive, Fish and Wildlife Conservation Strategy, as well as other species deemed in need of conservation by the Montana Natural Heritage Program and cooperating biologists. Several data sources were used to represent species habitat suitability: predictive models based on observation data, deductive models generated as part of the GAP effort, as well as expert opinion informed distributions. Species with greater combined state and global conservation status were given more weight in the cumulative score. **THIS ASSESSMENT DOES NOT INCLUDE INVERTEBRATES OR PLANTS.**



Class 1 (Highest)
Class 2
Class 3
Class 4 (Lowest)

MEASUREMENT UNIT AND MAPPING CONSIDERATIONS: Scores were calculated for each one - mile section in Montana. Species occurrence is based on modeling efforts informed by observations for most species. Individual species occurrences were modeled as 90-meter pixels and summarized to one-mile sections. Approximately 43,000 points observations were used to inform the modeling process; the number of points used per species ranged from 16 to over 4000. Observations were extracted from the shared FWP/NHP Point Observation Database. Only locations with less than 400 meters of uncertainty were used for modeling (with the exception of bird observations from the Breeding Bird Survey). Observations were not limited to recent observations.

DATA SOURCES

- ☐ Survey data – counts or estimates
- ☒ Survey data – categorical (e.g. presence/absence)
- ☒ Expert opinion based on observation

DATA EXTRAPOLATION TECHNIQUE USED

- ☐ None
- ☐ Modeling of habitat-species associations (deductive)
- ☒ Statistical modeling (inductive)
- ☐ Extrapolation to habitat unit (e.g. stream section)
- ☒ Extrapolation based on expert opinion

DATA SOURCE(S) / QUALITY: Species habitat suitability was predicted based on species observations and a variety of environmental features such as land cover, elevation, distance to stream, and precipitation. The models were created using MaxEnt software (Phillips et al. 2004; Phillips et al. 2006) and driven by point



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observations from the shared Montana Natural Heritage Program (MTNHP) and Montana Fish Wildlife and Parks (FWP) Point Observation Database (POD). Species with few (generally < 20) observations, as well as species for which predictive modeling clearly was not suitable (e.g., waterbirds) were represented using the original GAP models (insert citation) or expert-informed maps (Table 1). Grizzly bear distribution was represented by a layer depicting a 10-mile buffer around recovery areas. Lynx distribution was represented by boundary determined through expert review.

METHODS: All SOC were ranked using a formula that considered the Species of Concern (<http://mtnhp.org/SpeciesOfConcern>) state rank and the Natureserve global rank as determined by MTNHP and NatureServe, respectively. A model was created for each species that represented presence or absence. All model outputs were clipped to the known range of the species and then all species with the same rank were added together. Each rank group total was subjected to a multiplier (Table 1) and then the group scores were added to arrive at a final score. Scores were initially represented by 90-meter pixels.

FINAL CATEGORIZATION: All 90-meter pixels in a section were averaged to arrive at the final section score. Section values were broken into four classes using the natural breaks algorithm in ArcGIS; this algorithm finds gaps in the data corresponding to the number of categories desired.

CLASS	RANGE OF VALUES (points)	PERCENT OF STATE
1 (Highest)	8.0 to 13.75	18 %
2	6.25 to 8.0	33 %
3	4.25 to 6.25	34 %
4 (Lowest)	1 to 4.25	15 %

Table 1. Conservation species used in this layer (see model representation and footnotes for details).

Species	SRank	GRank	CLIP Rank ¹	# Of Obs. ²	Data Quality Rating ³	Model Representation ⁴
Coeur d'Alene Salamander	2	4	3	142	Moderate	MaxEnt
Idaho Giant Salamander	2	3	2	52	Low	MaxEnt
Western Toad	2	4	3	1735	High	MaxEnt
Great Plains Toad	2	5	3	296	Moderate	MaxEnt
Plains Spadefoot	3	5	4	459	Moderate	MaxEnt
Northern Leopard Frog	1	5	2	1290	High	MaxEnt
Common Loon	3	5	4	536	High	MaxEnt
Horned Grebe	3	5	4		Limited Validation	GAP
Clark's Grebe	3	5	4		Limited Validation	GAP
American White Pelican	3	4	4		Limited Validation	GAP
American Bittern	3	4	4		Limited Validation	GAP
Great Blue Heron	3	5	4	2403	High	GAP
Black-crowned Night-Heron	3	5	4		Limited Validation	GAP
White-faced Ibis	3	5	4		Limited Validation	GAP



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Species	SRank	GRank	CLIP Rank ¹	# Of Obs. ²	Data Quality Rating ³	Model Representation ⁴
Trumpeter Swan	3	4	4	29	Low	MaxEnt
Harlequin Duck	2	4	3	425	Moderate	MaxEnt
Bald Eagle	3	5	4	342	Moderate	MaxEnt
Northern Goshawk	3	5	4	375	Moderate	MaxEnt
Ferruginous Hawk	3	4	4	921	High	MaxEnt
Golden Eagle	3	5	4	4309	High	MaxEnt
Peregrine Falcon	3	4	4	360	Moderate	MaxEnt
White-tailed Ptarmigan	3	5	4		Limited Validation	OldGap
Greater Sage-Grouse	2	4	3			Handled elsewhere ⁵
Sharp-tailed Grouse	1	4	2			Handled elsewhere ⁵
Yellow Rail	3	4	4		Limited Validation	GAP
Whooping Crane	1	1	1			Only migratory in state
Piping Plover	2	3	2	736	Limited Validation	GAP
Mountain Plover	2	3	2	1784	High	MaxEnt
Black-necked Stilt	3	5	4		Limited Validation	GAP
Long-billed Curlew	3	5	4	1378	High	MaxEnt
Franklin's Gull	3	4	4		Limited Validation	GAP
Caspian Tern	2	5	3		Limited Validation	GAP
Common Tern	3	5	4		Limited Validation	GAP
Forster's Tern	3	5	4		Limited Validation	GAP
Least Tern	1	4	2	221	Moderate	MaxEnt
Black Tern	3	4	4		Limited Validation	GAP
Black-billed Cuckoo	3	5	4			Limited data ⁶
Yellow-billed Cuckoo	3	5	4			Limited data ⁶
Flammulated Owl	3	4	4	414	Moderate	MaxEnt
Burrowing Owl	3	4	4	442	Moderate	MaxEnt
Great Gray Owl	3	5	4	16	Low	MaxEnt
Black Swift	1	4	2	5	Limited Validation	GAP
Lewis's Woodpecker	2	4	3	15	Limited Validation	GAP
Red-headed Woodpecker	3	5	4			Limited data ⁶
Black-backed Woodpecker	3	5	4			Limited data ⁶
Pileated Woodpecker	3	5	4	23	Low	MaxEnt
Alder Flycatcher	3	5	4		Limited Validation	GAP
Pinyon Jay	3	5	4	173	Moderate	MaxEnt
Clark's Nutcracker	3	5	4	3987	High	MaxEnt
Boreal Chickadee	3	5	4	30	Low	MaxEnt
Brown Creeper	3	5	4	839	High	MaxEnt
Winter Wren	3	5	4	2681	High	MaxEnt
Sedge Wren	3	5	4			Limited data ⁶
Blue-gray Gnatcatcher	2	5	3		Limited Validation	GAP



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Species	SRank	GRank	CLIP Rank ¹	# Of Obs. ²	Data Quality Rating ³	Model Representation ⁴
Veery	3	5	4	458	Moderate	MaxEnt
Sage Thrasher	3	5	4	294	Moderate	MaxEnt
Sprague's Pipit	3	4	4	1877	High	MaxEnt
Loggerhead Shrike	3	4	4	554	High	MaxEnt
Brewer's Sparrow	3	5	4	2504	High	MaxEnt
Sage Sparrow	3	5	4			Limited data ⁶
Baird's Sparrow	3	4	4	1644	High	MaxEnt
Grasshopper Sparrow	3	5	4	2169	High	MaxEnt
Le Conte's Sparrow	3	4	4			GAP
Nelson's Sparrow	3	5	4	88	Low	MaxEnt
McCown's Longspur	3	4	4	984	High	MaxEnt
Chestnut-collared Longspur	2	5	3	3382	High	MaxEnt
Bobolink	3	5	4	486	Moderate	MaxEnt
Black Rosy-Finch	2	4	3		Limited Validation	GAP
Gray-crowned Rosy-Finch	2	5	3		Limited Validation	GAP
Cassin's Finch	3	5	4	2111	High	MaxEnt
Preble's Shrew	3	4	4			Limited data ⁶
Dwarf Shrew	2	4	3		Limited Validation	GAP
Arctic Shrew	1	5	2			Limited data ⁶
Merriam's Shrew	3	5	4		Limited Validation	GAP
Northern Short-tailed Shrew	1	5	2			Limited data ⁶
Fringed Myotis	3	4	4			Limited data ⁶
Northern Myotis	2	4	3			Limited data ⁶
Eastern Red Bat	2	5	3			Limited data ⁶
Hoary Bat	3	5	4	254	Moderate	MaxEnt
Spotted Bat	2	4	3			Limited data ⁶
Townsend's Big-eared Bat	2	4	3	129	Moderate	MaxEnt
Pallid Bat	2	5	3	31	Low	MaxEnt
Black-tailed Jack Rabbit	2	5	3	17	Low	MaxEnt
Pygmy Rabbit	3	4	4	1196	High	MaxEnt
Uinta Chipmunk	3	5	4			Limited data ⁶
Black-tailed Prairie Dog	3	4	4	1411	High	MaxEnt
White-tailed Prairie Dog	1	4	2		Limited Validation	GAP
Idaho Pocket Gopher	2-4	4	3			Limited data ⁶
Great Basin Pocket Mouse	2-3	5	3		Limited Validation	GAP
Hispid Pocket Mouse	1-3	5	2		Limited Validation	GAP
Northern Bog Lemming	2	4	3			Limited data ⁶
Meadow Jumping Mouse	2	5	3	29	Low	MaxEnt
Gray Wolf	3	4	4			Connectivity ⁷
Swift Fox	3	3	3	514	High	MaxEnt
Grizzly Bear	2	4	3		High	Expert Knowledge



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Species	SRank	GRank	CLIP Rank ¹	# Of Obs. ²	Data Quality Rating ³	Model Representation ⁴
Fisher	3	5	4			Handled elsewhere ⁸
Black-footed Ferret	1	1	1			Reintroductions ⁹
Wolverine	3	4	4			Handled elsewhere ⁸
Western Spotted Skunk	1-3	5	2		Limited Validation	GAP
Canada Lynx	3	5	4		High	Expert Knowledge
Bison	2	4	3			Few wild populations ¹⁰
Snapping Turtle	3	5	4	60	Low	MaxEnt
Spiny Softshell	3	5	4	155	Moderate	MaxEnt
Northern Alligator Lizard	3	5	4	48	Low	MaxEnt
Greater Short-horned Lizard	3	5	4	193	Moderate	MaxEnt
Common Sagebrush Lizard	3	5	4	266	Moderate	MaxEnt
Western Skink	3	5	4	54	Low	MaxEnt
Western Hog-nosed Snake	2	5	3	79	Low	MaxEnt
Milksnake	2	5	3	51	Low	MaxEnt
Smooth Greensnake	2	5	3	43	Low	MaxEnt

¹ Clip Rank was formed by combining SRank and GRank values, lower scores in these two categories led to lower Clip Ranks (greater conservation need).

²Number of observations indicates observations used for inductive (MaxEnt) modeling.

³Data Quality Ratings of Low, Moderate and High apply to inductive models.

⁴Model representation codes: MaxEnt = inductive modeling with Maximum Entropy, GAP = deductive models from GAP efforts at Montana Spatial Analysis Lab.

⁵These species were included in the Prairie Grouse Layer, a portion of the Terrestrial Game Layer.

⁶These species did not have enough observations with sufficient accuracy for modeling nor did they have GAP models. Data for these species is lacking.

⁷This species will be handled under a future connectivity analysis.

⁸These species were included in the Furbearer Layers, a portion of the Terrestrial Game Layer.

⁹This species currently only exists in Montana where experimental reintroductions have occurred.

¹⁰Populations of this species only occurred in small pockets of Montana currently.

REFERENCES:

Steven J. Phillips, Miroslav Dudík, Robert E. Schapire. A maximum entropy approach to species distribution modeling. In *Proceedings of the Twenty-First International Conference on Machine Learning*, pages 655-662, 2004.



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Steven J. Phillips, Robert P. Anderson, Robert E. Schapire. Maximum entropy modeling of species geographic distributions. *Ecological Modelling*, 190:231-259, 2006.

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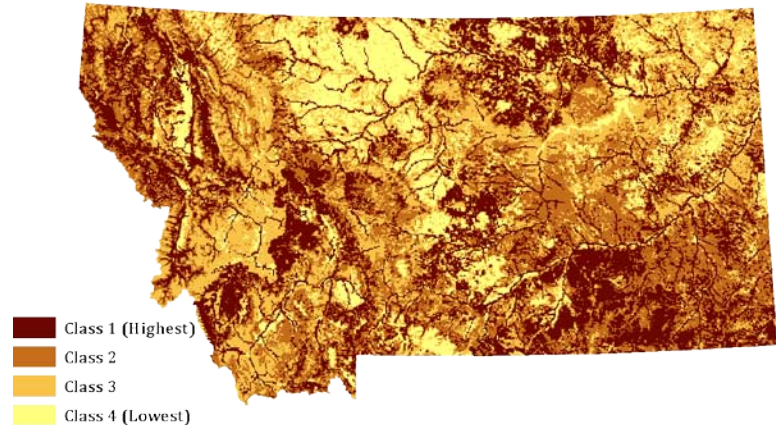
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Crucial Areas & Connectivity Assessment



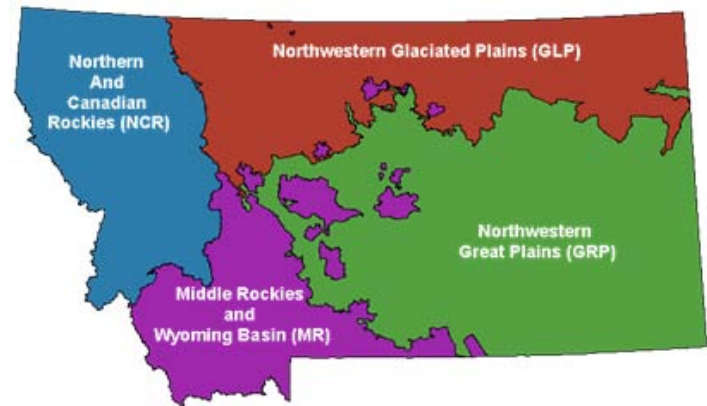
TERRESTRIAL SPECIES RICHNESS

SUMMARY: This layer represents species richness of all native land-based species in Montana, including amphibians, reptiles, birds, and mammals. Species included are found year round or breed in the state. The metric presented is the average number of species associated with all cover types (habitats) in each section. This data layer allows you to understand the overall number of species that is associated with each one mile section.



MEASUREMENT UNIT: One-mile section

DATA SOURCE(S) / QUALITY: A spatial dataset representing cover types (habitats), a species-habitat association database, and an ecoregion layer were used to create this layer. The Montana Land Cover, courtesy of Montana Natural Heritage Program (MTNHP) is a data layer created from satellite images that are categorized based on data collected from field measurements. There are 81 ecological classifications in Montana that represent communities such as sagebrush, coniferous forests and grasslands. The second source is a habitat association database created by MTNHP that



DATA SOURCES

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- ☒ Survey data – categorical (e.g. presence/absence)
- ☒ Expert opinion based on observation

DATA EXTRAPOLATION TECHNIQUE USED

- ☐ None
- ☒ Modeling of habitat-species associations (deductive)
- ☐ Statistical modeling (inductive)
- ☐ Extrapolation to habitat unit (e.g. stream section)
- ☐ Extrapolation based on expert opinion

associated all vertebrate species in Montana with Ecological Systems (habitats) according to the degree of association between the species and a given habitat: high, moderate, or low association. In an effort to compare ecologically different regions of Montana, four ecoregions based on Omernick Level 3 ecoregions (see Figure above), were created to summarize species richness . Area within each ecoregion was scored separately: 1)



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Northern and Canadian Rockies (NCR), 2) Middle Rockies, Idaho Batholith, & Wyoming Basin including island mountain ranges (MR), 3) Northern Glaciated Plains (GLP), and 4) Northwestern Great Plains (GRP).

METHODS: Habitats with “high” or “medium” suitability were used to create species-habitat associations for most vertebrate species in Montana. The resulting models were summed (taking into account the known range of each species) for each cell in the Ecological

CLASS	(Number of species associations)				% OF STATE
	NCR	MR	GLP	GRP	
1 (Highest)	90-176	61-129	68-103	74-103	29 %
2	71-89	55-60	52-68	60-74	29 %
3	48-70	42-55	17-51	32-59	28 %
4 (Lowest)	0-47	0-41	0-16	0-31	14 %

Systems layer. Scores for all cells in a given section were averaged to arrive at an average species richness score for each square-mile section. The highest scores (class 1) from both the wetland and riparian layers were “burned in” to this layer in the final step to account for high species richness that could not be represented using Montana Land Cover.

FINAL CATEGORIZATION: Raw scores were divided into four classes for each ecoregion. Scores from all four ecoregions were merged together to form a single statewide layer.

Table 1. Ecological systems used in richness calculations.

Ecological System (Ctrl + click system name to go to Montana Field Guide)
Great Plains Badlands
Rocky Mountain Cliff, Canyon and Massive Bedrock
Alpine Ice Field
Rocky Mountain Alpine Bedrock and Scree
Shale Badland
Great Plains Cliff and Outcrop
Active and Stabilized Dune
Wyoming Basin Cliff and Canyon
Aspen Forest and Woodland
Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest
Rocky Mountain Subalpine Woodland and Parkland
Rocky Mountain Mesic Montane Mixed Conifer Forest
Rocky Mountain Foothill Limber Pine-Juniper Woodland
Rocky Mountain Lodgepole Pine Forest
Rocky Mountain Ponderosa Pine Woodland and Savanna
Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland
Rocky Mountain Subalpine Mesic Spruce-Fir Forest and Woodland
Rocky Mountain Montane Douglas-fir Forest and Woodland
Rocky Mountain Poor Site Lodgepole Pine Forest
Great Plains - Black Hills Ponderosa Pine Woodland and Savanna
Aspen-Mixed Conifer Forest and Woodland
Mountain Mahogany Woodland and Shrubland



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Ecological System (Ctrl + click system name to go to Montana Field Guide)
Great Plains Wooded Draw and Ravine
Mat Saltbush Shrubland
Alpine Dwarf-Shrubland
Low Sagebrush Shrubland
Big Sagebrush Shrubland
Mixed Salt Desert Scrub
Great Plains Shrubland
Rocky Mountain Lower Montane-Foothill Shrubland
Rocky Mountain Montane-Foothill Deciduous Shrubland
Mountain Subalpine Deciduous Shrubland
Rocky Mountain Foothill Woodland Steppe Transition
Big Sagebrush Steppe
Montane Sagebrush Steppe
Rocky Mountain Lower Montane, Foothill and Valley Grassland
Rocky Mountain Subalpine-Upper Montane Grassland
Great Plains Mixedgrass Prairie
Alpine Fell-Field
Alpine Turf
Rocky Mountain Subalpine-Montane Mesic Meadow
Great Plains Sand Prairie
Greasewood Flat
Rocky Mountain Conifer Swamp
Northern Rocky Mountain Lower Montane Riparian Woodland and Shrubland
Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland
Great Plains Floodplain
Rocky Mountain Wooded Vernal Pool
Rocky Mountain Subalpine-Montane Riparian Woodland
Rocky Mountain Subalpine-Montane Riparian Shrubland
Great Plains Prairie Pothole
Alpine-Montane Wet Meadow
Great Plains Open Freshwater Depression Wetland
Emergent Marsh
Rocky Mountain Subalpine-Montane Fen
Great Plains Closed Depression Wetland
Great Plains Saline Depression Wetland
Great Plains Riparian

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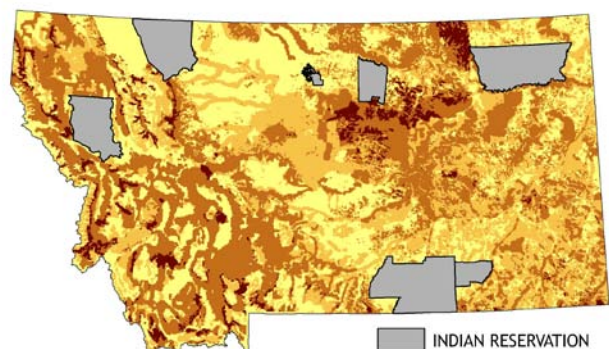
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TERRESTRIAL GAME QUALITY

SUMMARY: This layer depicts the relative value of areas based upon the specific habitat requirements of 12 native game species. These species were categorized into 4 functional groups: big game, bighorn sheep and mountain goat, prairie grouse, and forest carnivores. Area values were calculated by adding together the individual contribution of each species group, meaning that in areas of overlap values will generally be higher. However, it is important to realize that an area with a lower cumulative value can still contain high value habitat for just one species group. These 12 species were selected to represent the areas of highest value for native game in Montana, all other native game species are represented in the Terrestrial Species Richness layer.



INDIAN RESERVATION

- Class 1 (Highest)
- Class 2
- Class 3
- Class 4 (Lowest)

MEASUREMENT UNIT: Public land survey sections - approximately one square mile.

MAPPING CONSIDERATIONS: Indian reservations were not evaluated due to lack of data. National park lands are not currently represented in big game distribution layers and therefore have lower than expected values in some areas.

DATA SOURCE(S) / QUALITY:

Big Game: *Metric evaluated:* winter range habitat value. *Species:* pronghorn antelope, elk, moose, mule deer and white-tailed deer. *Data layers:* big game distribution - publicly available for individual species, maintained by FWP. Layers are updated using expert knowledge, including known habitat associations and extrapolation from survey data. Resolution is based on 1 square mile public land survey sections; Montana Land Cover Classification -layer maintained by the Montana Natural Heritage Program (NHP) Spatial Analysis Lab, University of Montana. Classification based on remote sensing. Resolution is 30 meters. **Bighorn sheep and mountain goat:** *Metric evaluated:* general and winter distribution. *Data layer:* big game distribution – see previous. **Forest carnivores:** *Metric evaluated:* habitat suitability. *Species:* wolverine, fisher,

marten. *Data layers:* furbearer harvest locations – maintained by FWP Mandatory Reporting System. Reporting at section level by trappers; Furbearer observation records – Maintained in NHP Point Observation Database. Accuracy verified by NHP staff; Wolverine primary habitat model – produced by the Wildlife Conservation Society; Fisher and marten habitat suitability model developed using known locations and reviewed by FWP biologists. Resolution is 90 meters.

DATA SOURCES

- ✓ Survey data – counts or estimates
- ✓ Survey data – categorical (e.g. presence/absence)
- ✓ Expert opinion based on observation

DATA EXTRAPOLATION TECHNIQUE USED

- None
- ✓ Modeling of habitat-species associations (deductive)
- ✓ Statistical modeling (inductive)
- Extrapolation to habitat unit (e.g. stream section)
- ✓ Extrapolation based on expert opinion

Prairie grouse: *Metric evaluated:* core habitat areas, lek areas, and habitat suitability. *Species:* sage-grouse, sharp-tail grouse. *Data layers:* sage-grouse and sharp-tail grouse lek locations and



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observations collected via ground and aerial surveys by FWP and Bureau of Land Management biologists – maintained in FWP sage-grouse database; Sage-grouse core areas – developed and maintained by FWP with input from Bureau of Land Management. Publicly available layer based expert knowledge review of sage-grouse habitat suitability model using lek locations and limited to areas of highest male density. Sharp-tail grouse habitat suitability model developed using lek locations and reviewed by FWP biologists. Resolution is 90 meters.

METHODS: **Big game** values were determined based upon the presence winter range habitat. The score assigned to particular areas varied by FWP Region (R#). In the Western mountains, areas identified as winter use areas in the species distribution layers received one point. In the Northwest (R1) winter use of Elk or White-tail Deer was given an additional point. In the Southwest (R2-3), Elk or Mule Deer was given an additional point. For the rest of the state, areas identified as winter use areas in the species distribution layers, as well as areas containing >50% sagebrush grassland, received one point. Areas identified as winter use for more than one species, or containing >75% sagebrush grassland were given an additional point. **Bighorn sheep and mountain goat** received 1 point for overall distribution and 2 points for winter use. In areas of species overlap, values were not cumulative, the highest value was chosen. **Forest carnivore** habitat values were 2 points for wolverine habitat; 2 points to highly suitable marten or fisher habitat; and 1 point to moderately suitable marten or fisher habitat. In areas of species overlap, values were cumulative to a maximum value of 6 points. Values were only calculated in western forest habitats where forest carnivores were expected. **Prairie grouse** habitat was valued by assigning 3 points to sage-grouse core areas and outside of core areas, 2 points were assigned to sage-grouse lek areas. Two points were assigned to highly suitable sharp-tail grouse habitat and 1 point to moderately suitable sharp-tail grouse habitat. In areas of species overlap, values were cumulative to a maximum value of 5 points. Values were only calculated in prairie areas where prairie grouse were expected. **Overall:** Within each species group, values were rescaled by dividing by the maximum number of points to give each category a value ranging from 0 to 1. In this way each group received equal weight. Big game winter habitat was given twice the weight in the final calculation based upon its level of importance. The final summed value was again rescaled to 0 to 1, by dividing by the total possible score for that section. For example, in eastern prairie areas the total possible score did not include forest carnivores.

FINAL CATEGORIZATION: The resulting scores ranged from 0 to 1. The mean (0.37) and the standard deviation (0.23 SD) of the final scores were calculated. Final categories were determined by assessing the deviation from the mean value. The highest category had values > 1.5 SD from the mean. The high category was 0.5 to 1.5 SD from the mean value. The moderate category ranged from -0.5 SD below the mean to 0.5 SD above the mean. The low category was < -0.5 SD from the mean. Actual values and percentage of land area are shown in the table.

CLASS	RANGE OF VALUES	PERCENT OF STATE
1 (Highest)	> 0.71	4.3 %
2	0.48 – 0.71	33.0 %
3	0.26 – 0.48	29.7 %
4 (Lowest)	< 0.26	33.0 %

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